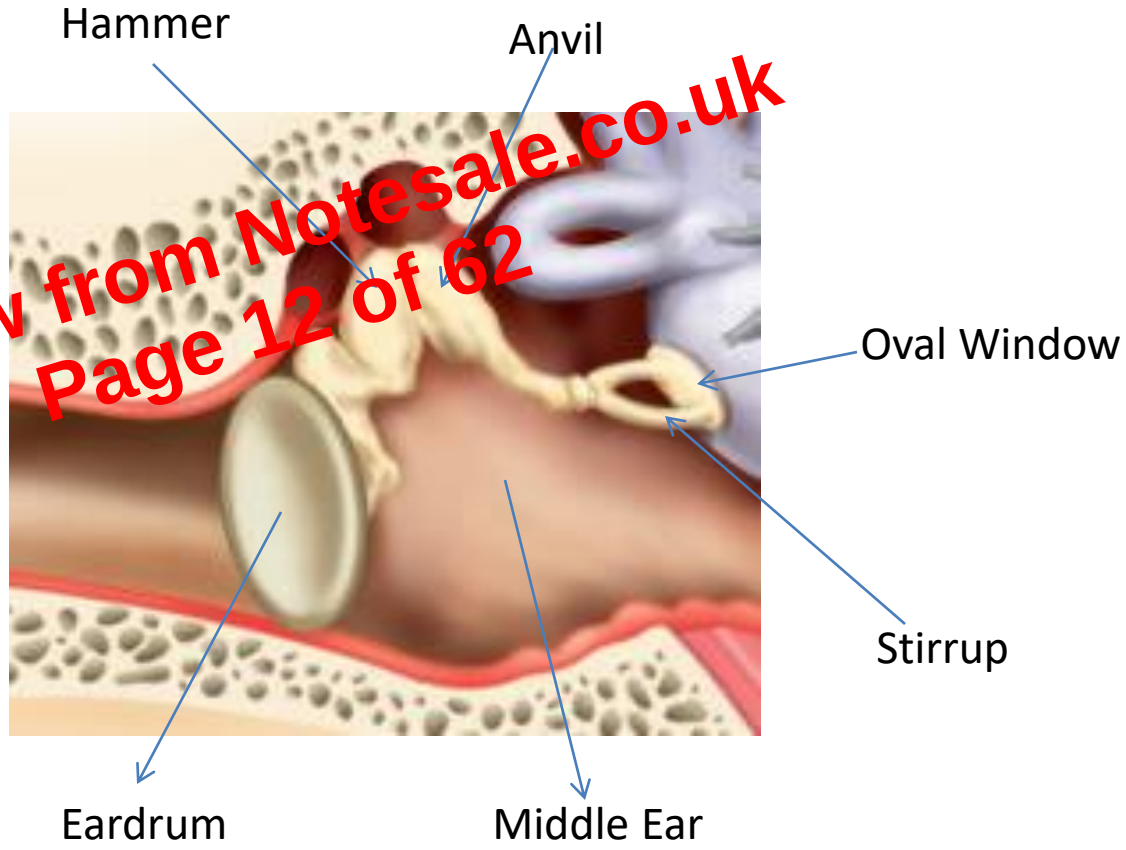
Just as a person's vision is limited by the visible spectrum of light, a person is also limited in the range of frequencies he or she can hear. Frequency is measured in cycles (waves) per second, or **hertz (Hz). Human limits are between 20 and 20,000 Hz**. (In comparison, dogs can hear between 50 and 60,000 Hz, and dolphins can hear up to 200,000 Hz.) To hear the higher and lower frequencies of a piece of music on a CD, for example, a person would need to increase the amplitude or volume.

(hertz (Hz) cycles or waves per second, a measurement of frequency.)



The middle ear. Sound waves entering through the ear canal cause the eardrum to vibrate, which causes each of the three bones of the middle ear to vibrate, amplifying the sound. The stirrup rests on the oval window, which transmits its vibration to the fluid in the inner ear.

In a cochlear implant, a microphone implanted just behind the ear picks up sound from the surrounding environment. A speech processor, attached to the implant and worn outside the body, selects and arranges the sound picked up by the microphone. The implant itself is a transmitter and receiver, converting the signals from the speech processor into electrical impulses that are collected by the electrode array in the cochlea and then sent to the brain.

This child is able to hear with the help of a cochlear implant. Hearing spoken language during the early years of a child's life helps in the development of the child's own speech.

Somatic pain is the body's warning system that something is being, or is about to be, damaged and tends to be sharp and fast. Another type of somatic pain is carried on small nerve fibers and is slower and more of a general ache. This somatic pain acts as a kind of reminder system, keeping people from further injury by reminding them that the body has already been damaged. For example, if you hit your thumb with a hammer, the immediate pain sensation is of the first kind—sharp, fast, and bright. But later the bruised tissue simply aches, letting you know to take it easy on that thumb.

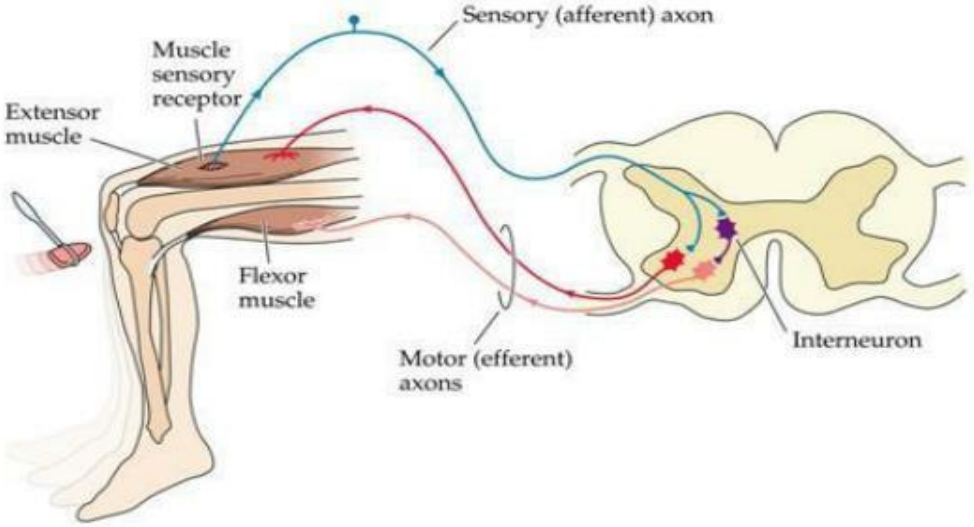
PAIN: GATE-CONTROL THEORY

The best current explanation for how the sensation of pain works is called ***gate-control theory, first proposed by Melzack and Wall (1965).*** In this theory, the pain signals must pass through a "gate" located in the spinal cord. The activity of the gate can be closed by non pain signals coming into the spinal cord from the body and by signals coming from the brain. The gate is not a physical structure but instead represents the relative balance in neural activity of cells in the spinal cord that receive information from the body and then send information to the brain.

Stimulation of the pain receptor cells releases a chemical called ***substance P*** *(for* "pain," naturally). Substance P released into the spinal cord activates other neurons that send their messages through spinal gates (opened by the pain signal).

Kinesthetic receptors

- Mechanoreceptors in muscles, tendons and joints
- Tell you where your limbs are and how they are moving
- In the reflex arc they encode muscle stretch



Kinesthesis: the sense that provides information through receptors in the muscles, tendons, and joints, enabling humans and other animals to control and coordinate their movements, including walking, talking, facial expressions, gestures, and posture. Also called kinaesthesia; kinesthetic sense; movement sense.

kinesthetic receptor : any of the sensory receptors that monitor the position and movement of muscles. These are found in muscles, tendons, and joints.

Kinesthetics: awareness of the position and movement of body parts.

The vestibular labyrinth is made up of the semicircular canals and the otolith organs, and contains receptors for vestibular sensations. These receptors send vestibular information via the vestibulocochlear nerve to the cerebellum and to nuclei in the brainstem called the vestibular nuclei. The vestibular nuclei then pass the information on to a variety of targets, ranging from the muscles of the eye to the cerebral cortex.

A) The *otolith organs* *are tiny sacs found just above the cochlea. These sacs contain a* gelatin-like fluid within which tiny crystals are suspended. The head moves and the crystals cause the fluid to vibrate, setting off some tiny hair like receptors on the inner surface of the sac, telling the person that he or she is moving forward, backward, sideways, or up and down.

B) B)The *semicircular canals* *are three somewhat circular tubes that are also filled with* that will stimulate hair like receptors when rotated. Having three tubes allows one to be located in each of the three planes of motion. *Those are the three planes through which the body can* rotate, and when it does, it sets off the receptors in these canals. When you spin around and then stop, the fluid in the horizontal canal is still rotating and will make you feel dizzy because your body is telling you that you are still moving, but your eyes are telling you that you have stopped.